CHATTANOOGA
GROUP, INC.

Intelect® Legend Series
Service Manual

P.N. 78343 Rev. A

I NEED TO KNOW . . .

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First look on this page to quickly find where to go in the manual for more information !

Intelect® Legend Two Year Limited Warranty

The Chattanooga Group Inc. ("Company") warrants that the Intelect® Legend Ultrasound or Stim ("Product") excluding accessories is free of defects in material and workmanship.

This warranty shall remain in effect for two (2) years from the date of the original consumer purchase of this and extends to any owner of the product during the warranty period. Accessories that are included as standard with the product (as listed in the user's manual) are warranted for 90 days. Ultrasound applicators $2cm^2$, $5cm^2$ or $10cm^2$ are warranted for one (1) year. If this product fails to function during the two year warranty period because of a defect in material or workmanship, the company or the selling dealer will replace or repair this product without charge within a period of 30 days from the date on which the defective product is returned to the company or dealer. The company or the dealer will ship the replacement or the repaired product to the owner.

All repairs must be performed by a service center authorized by the Chattanooga Group, Inc. Any modifications or repairs performed by unauthorized centers or groups will void this warranty. To participate in warranty coverage, the product's warranty registration card (included with the product) must be filled out and returned to the Chattanooga Group, Inc. by the original owner within 10 business days of purchase.

This warranty does not cover:

Replacement parts or labor furnished by anyone other than the Company, the dealer or an approved Company service agent.

Defects or damage caused by labor furnished by someone other than Company, the dealer or an approved Company service agent.

Any malfunction or failure in the product while it is in the possession of the owner during the warranty period if the malfunction or failure is not caused by a defect in material or workmanship or if the malfunction or failure is caused by unreasonable use, applications in which the product was not intended or the failure to provide reasonable and necessary maintenance.

The Company shall Not be Liable for Incidental or Consequential Damages.

To Obtain Service:

From Company or the selling dealer under this warranty, the owner must do or abide by the following:

- A written claim must be made within the warranty period to Company or the selling dealer.
- If the claim is made to the Company, the written claim should be sent to:

  4717 Adams Road, P.O. Box 489

  Hixson, TN 37343

  Phone: (800) 592-7329
- The product must be returned to Company or the selling dealer by the owner.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

The Company does not authorize any person or representative to create for it any other obligation or liability in connection with the sale of the Product. Any representation or agreement not contained in the warranty shall be void and of no effect.

Start Here

About This Manual

This manual is intended to cover the Intelect® Legend Ultrasound and Stim units and their accessories only.

The purpose of this service manual is to give a qualified technician enough information to troubleshoot problems to the board level. Because of the complexity and construction of these boards it is not recommended that problems be traced to the component level. Some problems may be due to a misunderstanding of how the machine operates. Thus it is important to read the operators manual first to gain familiarity with how the machine operates under normal circumstances.

Since this service manual is intended to assist in isolating the problem to a circuit board, we will not cover the functions performed on each board in detail.

This manual presents a brief theory of operation of each board and accessory in the unit. It contains a troubleshooting guide for common problems. This guide is not meant to cover every possible problem that a service technician might encounter, but rather to give examples of what may be seen. The manual also contains diagrams of the connector layout of each board, a system diagram of how the unit is wired, and a list of signals carried on each wire. Also included are calibration procedures for the unit, parts lists and information on obtaining service.

Important !

The specifications and information put forth in this manual were in effect at the time of publication. However, owing to Chattanooga Group's policy of continuous improvement, changes to these may be made at any time without obligation on the part of Chattanooga Group, Inc.

Specifically, as there are improvements made to the circuit boards in these units **the connector names may change**. However, **the location and function of the connector will not likely change**. Use reasonable judgment and contact Chattanooga Group when in doubt.

Chattanooga Group, Inc., obviously cannot be responsible for work performed on their units by individuals or other companies not approved or authorized to perform service on Chattanooga Group equipment. Always try to resolve any problems through your dealer or Chattanooga Group's customer service department FIRST.

Please read and understand the following precautions before using or servicing a unit.

PRECAUTIONARY INSTRUCTIONS

As with any electrical device, **use extreme caution while working inside the devices. Some of the circuits produce high voltages** which may be accessible while servicing the unit. Be especially mindful of jewelry and tools that may accidentally come in contact with components inside the unit.

Most of the electronic components incorporated in the unit are electrostaticly sensitive. **Always wear a static grounding strap and work on a static dissipative surface.**

CAUTION: Read, understand and practice the precautionary and operating instructions contained in the unit's manual and in this service manual. Know the limitations and hazards associated with using any ultrasound device. Observe the precautionary and operational decals placed on the unit.

CAUTION: Do not operate the Intelect® Legend Unit when connected to any unit other than Chattanooga Group, Inc., devices. Do not operate the unit in an environment of short-wave diathermy use.

WARNING: Federal Law restricts this device to sale by, or on the order of, a physician or licensed practitioner. This device should be used only under the continued supervision of a physician or licensed practitioner.

CAUTION: The ultrasound generator should be routinely checked before each use to determine that all controls function normally; especially that the intensity control does properly adjust the intensity of the ultrasonic power output in a stable manner. Also, determine that the treatment time control does actually terminate ultrasonic power output when the timer reaches zero.

CAUTION: Use of controls or adjustments or performance of procedures other than those specified in the unit's manual or in this service manual may result in hazardous exposure to ultrasonic energy.

CAUTION: DO NOT use sharp objects such as a pencil point or ball point pen to operate the buttons on the control panel as damage may result.

WARNING: Explosion hazard if used in the presence of flammable anesthetics. The warning symbol for this hazard is prominently displayed on the cabinet.

WARNING: For continued protection against fire hazard, replace fuses only with ones of the same type and rating.

WARNING: Make certain that the unit is electrically grounded by connecting only to a grounded electrical service receptacle conforming to the applicable national and local electrical codes.

WARNING: This device should be kept out of the reach of children.

Theory of Operation

Overview

To better understand the details in the following paragraphs, a quick look at the operation of the entire system is helpful.

The unit is powered by a desktop switching power supply which accepts 100-240VAC and delivers a regulated 12-16VDC. Each board within the unit has its own local regulation as required by the particular board functions.

The user interface consists of the membrane switch panel on the top of the case and the LCD parameter screen for the Stim unit or LED displays for the Ultrasound unit. Choices presented on the LCD screen are selected via the membrane switches for the Stim unit while selections are made directly from the membrane switches and reflected in the LED displays on the Ultrasound unit. After a treatment is started on the Stim unit, the LCD screen returns to a display showing the status of the outputs. The LED displays constantly reflect the status of the Ultrasound unit. Alarms and feedback of keypresses are provided by a beeper located inside the case.

Connection for the ultrasound applicator and for electrode lead wires are made to panels on the side of the unit. The rear of the unit has the power supply input connector, the fuse and the fan.

Accessories supplied with all Ultrasound units include at least one applicator and ultrasound gel. Stim units have electrode leads and electrodes.

The Control Boards

- The Ultrasound Control Board

The signals controlling the Ultrasound Generator Board are carried through a 40 conductor cable from JP5 on the Control Board to J1 on the US Generator Board. Refer to the signal list. The signals include address and data lines, handshake lines and power supply controls.

Connector JP6 is for the membrane switches. JP1 is the power supply connector and supplies power from the desktop power supply.

JP2 is the output power connector for the Ultrasound Generator Board.

JP4 supplies power to the fan and JP3 is for the beeper.

- The Stim Control Board

The signals controlling the Stim Board leave JP7 on the Control Board and go through a 40 conductor cable to JP1 on the Stim Board. See the Signal List for details. Signals include address and data lines, handshake lines, and power supply control signals.

Connector JP4 is for the LCD screen. It is mounted directly behind the board and against the front panel. JP9 carries power for the electroluminescent backlighting.

Connector JP10 is for the membrane switches. JP1 is the power supply connector and supplies power from the desktop power supply.

JP2 is the output power connector for the Stim Board.

JP3 supplies power to the fan and JP6 is for the beeper.

The Stim Board

The Stim Board's function is to generate various output waveforms under the direction of the Control Board. Due to the variety of waveforms commonly used in electrotherapy, there are different waveform generators on the board, all controlled by a common Digital Signal Processor (DSP).

- The Sine Wave Generators

There are two of these on each Stim Board, one for channel 1 and the other for channel 2. Each is identical except for their connections to the output jacks. Under control of the DSP, Programmable Array Logic (PAL) devices generate a driving signal which is fed to an amplifier. The output amplitude of the amplifier is determined by a programmable power supply, also controlled by the DSP. The resulting output is filtered and routed by relays to the appropriate connector on the board.

These same generators are used to develop the VMS, or Biphasic output, the Premod output, the Interferential output and the Russian output.

- The Hi-Volt Generator

The Hi-Volt output is only available from channel 2 of the unit. Under control of the DSP, timing information is generated by a PAL. This is used to control the charging and discharging of a transformer. The discharges are routed through relays to obtain the proper polarity and connect them to the proper output connector on the board.

JP2 on the Stim Board determines whether the board operates as channels 1&2 or 3&4 on a CPS 400. This jumper must be set for channels 1&2 for the unit to operate properly. See the board drawing in the Signal Lists section for jumper configuration.

The Ultrasound Board

The Ultrasound Board uses a Phase Locked Loop (PLL) that is set by a PAL based on control by the Control Board to generate a stable high frequency signal. This signal is used to drive an amplifier whose output is filtered and drives the transducer. The amplitude of the amplifier output is determined by its programmable power supply. Other circuitry monitors the temperature of the transducer as well as voltage and current of the drive to the transducer.

The Ultrasound Board is controlled by signals from connector JP5 of the Control Board that are carried through a 40 conductor cable to J1 on the Ultrasound Board. The signals consist of address and data lines as well as handshake lines. There are also signals for turning off the power supplies on the Ultrasound Board when it is not generating output.

The power for the Ultrasound Board is through J2. Connector J3 is the output of the Ultrasound Board which ultimately drives the transducer in the applicator.

The Ultrasound Applicator

The Ultrasound Applicator comes in several models, depending on the surface area of the transducer and the shape of the face of the transducer. The circuitry within all of them is the same.

Connection to the Applicator is through a triaxial cable. The center conductor carries the drive to the transducer while the inner shield is the return. The outer shield is used to monitor the transducer temperature using a thermistor inside the Applicator.

A small circuit board inside the Applicator holds components for transducer temperature sensing and the memory device. The memory device stores the frequency and power information for the transducer. The memory device communicates via the two shields of the cable.

The Membrane Switch Panel

The membrane switch panel connects to JP6 on the Ultrasound Control Board and JP10 on the Stim Control Board. The switches are electrically arranged such that one side of all the switches have a common return. The other side of the switches are brought out individually to the connector. The switch activations are buffered and latched on the Control Boards.

The LCD Parameter Screen

The LCD parameter screen mounts between the Control Board and the top of the case. The interface between the LCD and the Stim Control Board's JP4 is a bi-directional 8-bit bus along with handshake signals. There is a separate connection via JP9 for supplying power to the electroluminescent backlight of the LCD. There is a module mounted on the Control Board which generates the necessary voltage for this.

The LED Interface

The LED displays mount on the solder side of the Ultrasound Control Board so as to show through the overlay on the case. They are soldered directly to the board and therefore are not replaceable.

General Service Procedures

Preventing damage to the case

The plastic case of the Intelect units is quite durable, as are the membrane switch overlays. To remove the screws and open the case for servicing it will be necessary to place the unit upside down. Be sure the work surface is covered so that the unit isn't scratched. Also be careful with tools that may scratch the case or overlays.

Location of screws

There are 6 screws that hold the case together and all of them are accessible from the bottom of the unit. These screws are distinguished from others on the bottom in that they are all recessed into the plastic case. Remove all 6 screws.

Opening the Case

Flip the unit back over and carefully lift the top of the case off the bottom. The top of the case can be opened from the left and put on the right side of the bottom without disconnecting the cables. If you do need to remove any cables, NOTE THE ORIENTATION of these cables BEFORE unplugging them because pin 1 is not marked on all the PC Boards. Mark the cable or connector and the board before unplugging with a permanent marker, tape or other means if you need to. You will also need to make note of which small 2-wire connector is for the fan and which is for the beeper. If these become swapped when assembling the unit, the beeper will sound continuously whenever the power is on.

Special Tools

Most any operation can be performed without any special tools. If you need to replace the EPROMs or PALs on any of the boards, you **MUST** use a special tool to remove the parts. Attempting to remove these IC's in any other way can damage the socket and make the entire circuit board unusable. The preferred tool is Burndy QILEXT-1, sold by Newark Electronics as type 290N, P/N 95F3004.

Closing the case

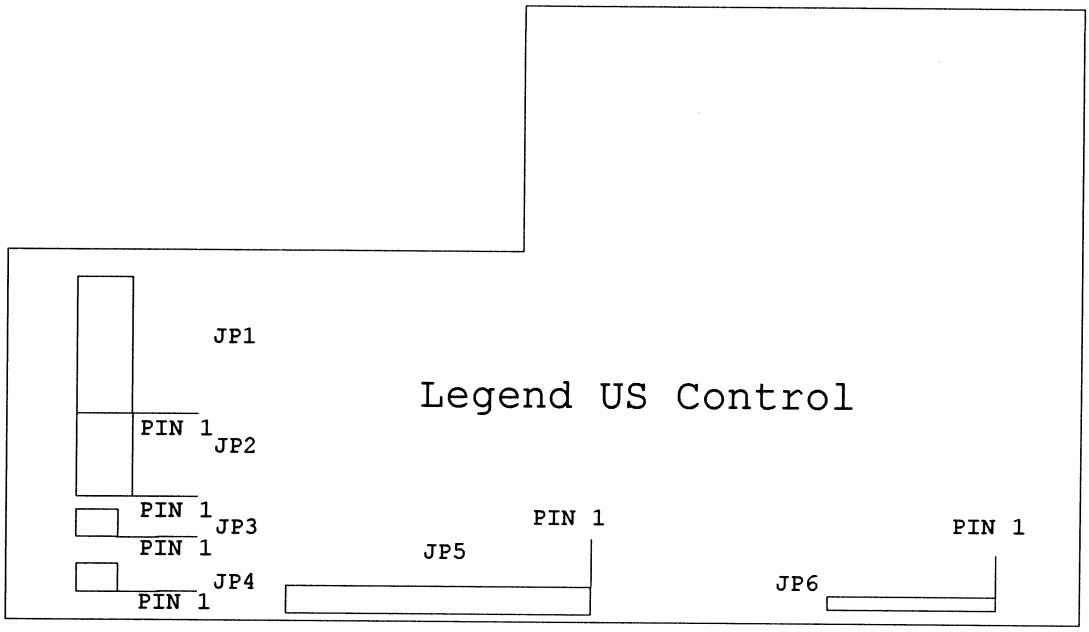
Re-assemble the unit taking care to properly install any cables you may have disconnected. When lowering the top down onto the bottom, be careful not to capture any wires in the edge of the case. If you are having difficulty it may be necessary to align one side of the case and then force the other side to align. Also notice that the metal plates on either side must align with plastic structures inside the case. After all this work look around the edge of the case one last time to be sure everything looks OK. Now the back panel may have fallen into the cabinet while aligning the top and bottom - don't panic. Carefully lift the rear edge of the top just enough to allow you to pull the panel back into its slot in the top and bottom of the case.

Hold the unit together and flip it over (once again be sure the table is covered so that the case isn't scratched) and put the 6 screws back in place. Don't overtighten the screws, tighten them just until the edges of the case seat together.

Signal Lists

Intelect® Ultrasound Control Board

Below is a simple drawing showing the approximate locations of the connectors and the position of pin 1 on each connector.



Below are tables showing the signals for each connector on the Control Board. The columns are arranged as pin number, signal description, type of signal and any other notable information about the signal.

JP1	US Control Board		
Pin #	Signal Name	Type	
1	Battery In	Power	Unused
2	Battery In	Power	Unused
3	Power Supply In	Power	+8 to +18 VDC
4	Power Supply In	Power	+8 to +18 VDC
5	Ground		
6	Ground		

JP2	US Control Board		
Pin #	Signal Name	Type	
1	Power Out	Power	+8 to +18 VDC
2	Power Out	Power	+8 to +18 VDC

3	Ground		
4	Ground		

JP3	US Control Board		
Pin #	**Signal Name**	**Type**	
1	Unregulated Power	Power	+8 to +18VDC, Current Limited
2	Buzzer On	Output	Open Collector, Active Low

JP4	US Control Board		
Pin #	**Signal Name**	**Type**	
1	Unregulated DC	Power	8-18VDC
2	Fan On	Output	Open Collector, Active Low

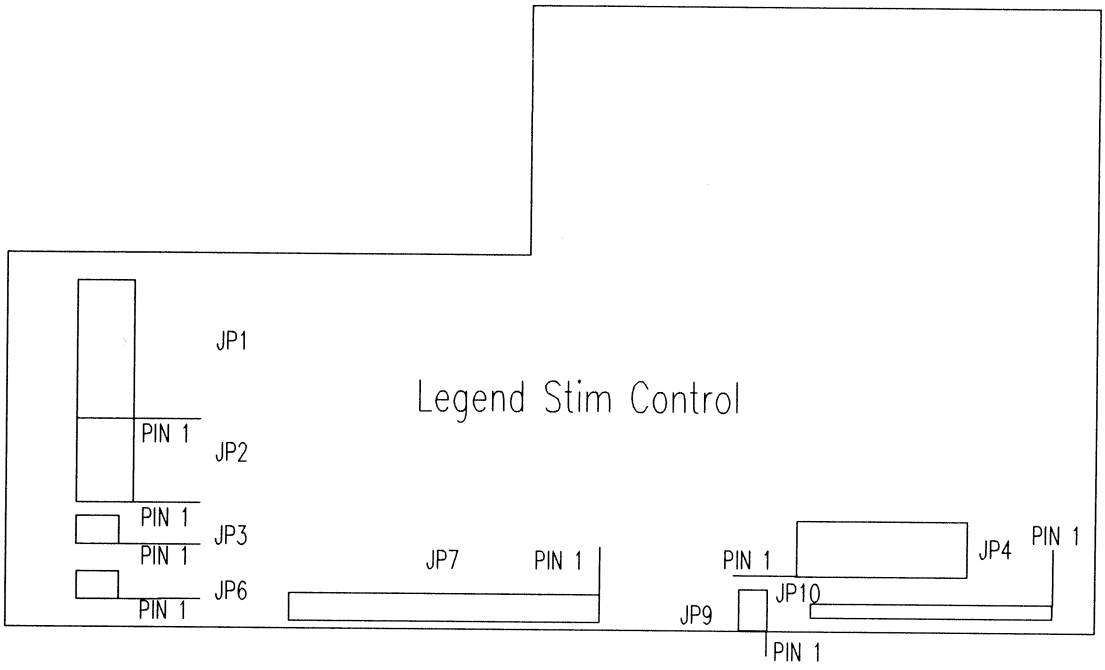
JP5	US Control Board		
Pin #	**Signal Name**	**Type**	
1	Ground		
2	US Data Line 0	Bi-Directional	Digital
3	Ground		
4	US Data Line 1	Bi-Directional	Digital
5	Ground		
6	US Data Line 2	Bi-Directional	Digital
7	Ground		
8	US Data Line 3	Bi-Directional	Digital
9	Ground		
10	US Data Line 4	Bi-Directional	Digital
11	Ground		
12	US Data Line 5	Bi-Directional	Digital
13	Ground		
14	US Data Line 6	Bi-Directional	Digital
15	Ground		
16	US Data Line 7	Bi-Directional	Digital
17	Ground		
18	No Connection		
19	Ground		
20	US Address Line 0	Output	Digital
21	Ground		
22	US Address Line 1	Output	Digital
23	Ground		
24	No Connection		

25	Ground		
26	No Connection		
27	Ground		
28	No Connection		
29	Ground		
30	US Strobe	Output	Digital Active Low
31	Ground		
32	US Board Enable	Output	Digital Active Low
33	Ground		
34	US Read/Write	Output	Digital Active Low
35	Ground		
36	No Connection		
37	Ground		
38	US Power Down 1	Output	Digital
39	Ground		
40	US Power Down 2	Output	Digital

JP6	**US Control Board**		
Pin #	**Signal Name**	**Type**	
1	Ground		
2	Switch 0	Input	Digital Active Low
3	Switch 1	Input	Digital Active Low
4	Switch 2	Input	Digital Active Low
5	Switch 3	Input	Digital Active Low
6	Switch 4	Input	Digital Active Low
7	Switch 5	Input	Digital Active Low
8	Switch 6	Input	Digital Active Low
9	Switch 7	Input	Digital Active Low
10	Switch 8	Input	Digital Active Low
11	Switch 9	Input	Digital Active Low
12	Switch 10	Input	Digital Active Low

Intelect® Legend Stim Control Board

Below is a simple drawing showing the approximate locations of the connectors and the position of pin 1 on each connector.



Below are tables showing the signals for each connector on the Control Board. The columns are arranged as pin number, signal description, type of signal and any other notable information about the signal.

JP1	Stim Control Board		
Pin #	**Signal Name**	**Type**	
1	Battery In	Power	Unused
2	Battery In	Power	Unused
3	Power Supply In	Power	+8 to +18 VDC
4	Power Supply In	Power	+8 to +18 VDC
5	Ground		
6	Ground		

JP2	Stim Control Board		
Pin #	**Signal Name**	**Type**	
1	Power Out	Power	+8 to +18 VDC
2	Power Out	Power	+8 to +18 VDC

3	Ground		
4	Ground		

JP3	Stim Control Board		
Pin #	**Signal Name**	**Type**	
1	Unregulated Power	Power	+8 to +18VDC, Current Limited
2	Buzzer On	Output	Open Collector, Active Low

JP4	Stim Control Board		
Pin #	**Signal Name**	**Type**	
1	Ground		
2	Ground		
3	VCC	Power	+5 Volts
4	LCD Bias	Power	-6 to -18 VDC, varies with contrast
5	LCD Write	Output	Digital Active Low
6	LCD Read	Output	Digital Active Low
7	LCD Chip Enable	Output	Digital Active Low
8	LCD Command / Data Select	Output	Digital - Data is Active Low
9	No Connection		
10	LCD Reset	Output	Digital Active Low
11	LCD Data Line 0	Bi-Directional	Digital
12	LCD Data Line 1	Bi-Directional	Digital
13	LCD Data Line 2	Bi-Directional	Digital
14	LCD Data Line 3	Bi-Directional	Digital
15	LCD Data Line 4	Bi-Directional	Digital
16	LCD Data Line 5	Bi-Directional	Digital
17	LCD Data Line 6	Bi-Directional	Digital
18	LCD Data Line 7	Bi-Directional	Digital
19	Ground		
20	No Connection		

JP6	Stim Control Board		
Pin #	**Signal Name**	**Type**	
1	Unregulated DC	Power	8-18VDC

2	Fan On	Output	Open Collector, Active Low

JP7	Stim Control Board		
Pin #	**Signal Name**	**Type**	
1	Dual Port RAM Interrupt	Input	Digital Active Low
2	Address Line 0	Output	Digital
3	Ground		
4	Address Line 1	Output	Digital
5	Dual Port RAM Busy	Input	Digital Active Low
6	Address Line 2	Output	Digital
7	Ground		
8	Address Line 3	Output	Digital
9	Dual Port RAM Read/Write	Output	Digital
10	Address Line 4	Output	Digital
11	Ground		
12	Address Line 5	Output	Digital
13	Dual Port RAM Output Enable	Output	Digital Active Low
14	Address Line 6	Output	Digital
15	Ground		
16	Address Line 7	Output	Digital
17	Dual Port RAM Chip Enable Board 1	Output	Digital Active Low
18	Address Line 8	Output	Digital
19	Dual Port RAM Chip Enable Board 2		Active Low
20	Address Line 9	Output	Digital
21	Ground		
22	Patient Disconnect	Output	Digital
23	Stim Channel 1 Power-Down	Output	Digital
24	No Connection		
25	Ground		
26	Stim Data Line 0		
27	MicroCurrent Probe Switch	Input	Digital
28	Stim Data Line 1	Bi-Directional	Digital
29	Ground		

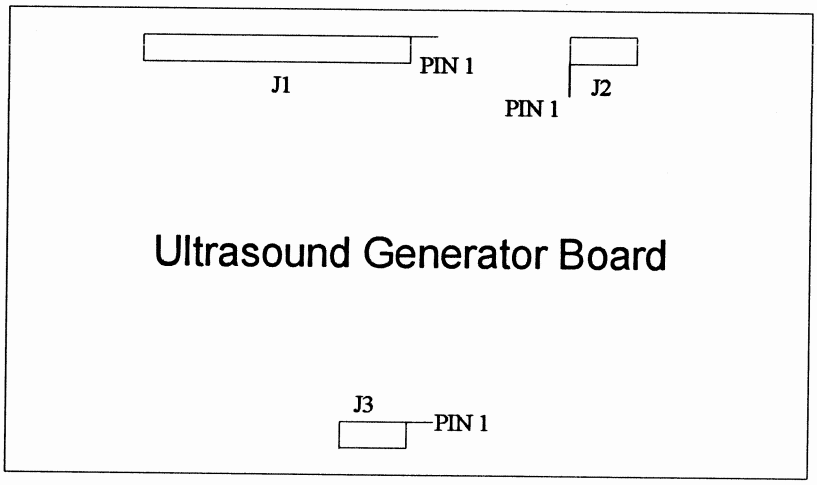
30	Stim Data Line 2	Bi-Directional	Digital
31	Ground		
32	Stim Data Line 3	Bi-Directional	Digital
33	Ground		
34	Stim Data Line 4	Bi-Directional	Digital
35	Stim Channel 2 Power-Down	Output	Digital
36	Stim Data Line 5	Bi-Directional	Digital
37	Ground		
38	Stim Data Line 6	Bi-Directional	
39	Stim Reset	Output	Digital Active Low
40	Stim Data Line 7	Bi-Directional	Digital

JP9	**Stim Control Board**		
Pin #	**Signal Name**	**Type**	
1	Backlight Power	Power	Approx. 100VAC, Approx. 400Hz
2	Ground		

JP10	**Stim Control Board**		
Pin #	**Signal Name**	**Type**	
1	Ground		
2	Switch 0	Input	Digital Active Low
3	Switch 1	Input	Digital Active Low
4	Switch 2	Input	Digital Active Low
5	Switch 3	Input	Digital Active Low
6	Switch 4	Input	Digital Active Low
7	Switch 5	Input	Digital Active Low
8	Switch 6	Input	Digital Active Low
9	Switch 7	Input	Digital Active Low
10	Switch 8	Input	Digital Active Low
11	Switch 9	Input	Digital Active Low
12	Switch 10	Input	Digital Active Low
13	Switch 11	Input	Digital Active Low
14	Switch 12	Input	Digital Active Low
15	Switch 13	Input	Digital Active Low
16	Switch 14	Input	Digital Active Low
17	Switch 15	Input	Digital Active Low

Ultrasound Generator Board

Below is a simple drawing showing the approximate locations of the connectors and the position of pin 1 on each connector.



Below are tables showing the signals for each connector on the Control Board. The columns are arranged as pin number, signal description, type of signal and any other notable information about the signal

J1	Ultrasound Generator Board		
Pin #	**Signal Name**	**Type**	
1	Ground		
2	US Data Line 0	Bi-Directional	Digital
3	Ground		
4	US Data Line 1	Bi-Directional	Digital
5	Ground		
6	US Data Line 2	Bi-Directional	Digital
7	Ground		
8	US Data Line 3	Bi-Directional	Digital
9	Ground		
10	US Data Line 4	Bi-Directional	Digital
11	Ground		
12	US Data Line 5	Bi-Directional	Digital
13	Ground		
14	US Data Line 6	Bi-Directional	Digital
15	Ground		

16	US Data Line 7	Bi-Directional	Digital
17	Ground		
18	No Connection		
19	Ground		
20	US Address Line 0	Input	Digital
21	Ground		
22	US Address Line 1	Input	Digital
23	Ground		
24	No Connection		
25	Ground		
26	No Connection		
27	Ground		
28	No Connection		
29	Ground		
30	US Strobe	Input	Digital Active Low
31	Ground		
32	US Board Enable	Input	Digital Active Low
33	Ground		
34	US Read/Write	Input	Digital Active Low
35	Ground		
36	No Connection		
37	Ground		
38	US Control Circuitry Power Down	Input	Digital
39	Ground		
40	US Amplifier Power Down	Input	Digital

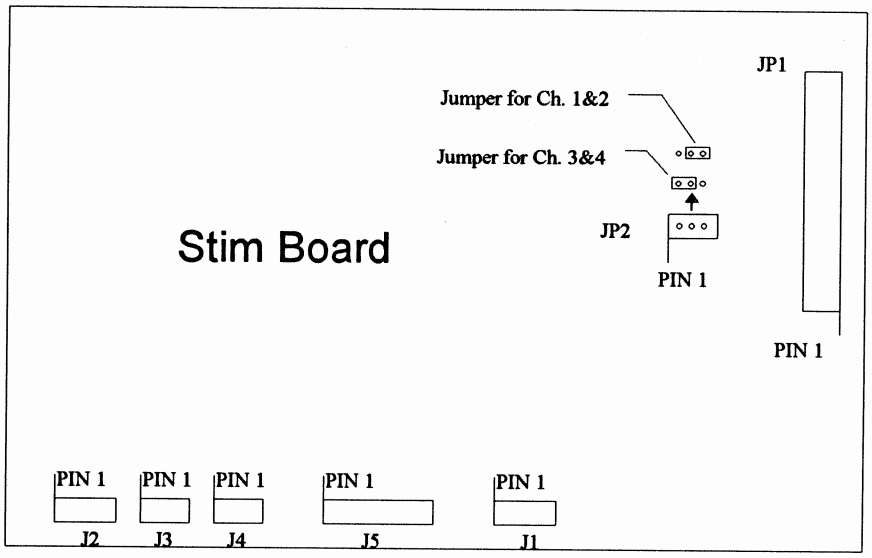
J2	**Ultrasound Generator Board**		
Pin #	**Signal Name**	**Type**	
1	DC Power Input	Input	8-18 VDC
2	DC Power Input	Input	8-18 VDC
3	Ground		
4	Ground		

J3	**Ultrasound Generator Board**		
Pin #	**Signal Name**	**Type**	
1	US Generator Output	Output	0-50V, 1-3 MHz Sine Wave
2	Ground		

3	Calibration Read/Write OR Ground	Bi-Directional	5V Digital During Read 12V Digital During Write
4	Ground		

Stim Board

Below is a simple drawing showing the approximate locations of the connectors and the position of pin 1 on each connector.



Below are tables showing the signals for each connector on the Control Board. The columns are arranged as pin number, signal description, type of signal and any other notable information about the signal. Note that the jumper on JP2 MUST be positioned for channels 1&2 for the Stim unit to operate.

JP1	Stim Board		
Pin #	**Signal Name**	**Type**	
1	Dual Port RAM Interrupt	Output	Digital Active Low
2	Address Line 0	Input	Digital
3	Ground		
4	Address Line 1	Input	Digital
5	Dual Port RAM Busy	Output	Digital Active Low
6	Address Line 2	Input	Digital
7	Ground		
8	Address Line 3	Input	Digital
9	Dual Port RAM Read/Write	Input	Digital
10	Address Line 4	Input	Digital
11	Ground		

12	Address Line 5	Input	Digital
13	Dual Port RAM Output Enable	Input	Digital Active Low
14	Address Line 6	Input	Digital
15	Ground		
16	Address Line 7	Input	Digital
17	Dual Port RAM Chip Enable Board 1	Input	Digital Active Low
18	Address Line 8	Input	Digital
19	Dual Port RAM Chip Enable Board 2		Active Low
20	Address Line 9	Input	Digital
21	Ground		
22	Patient Disconnect	Input	Digital
23	Stim Channel 1 Power-Down	Input	Digital
24	No Connection		
25	Ground		
26	Stim Data Line 0		
27	MicroCurrent Probe Switch	Output	Digital
28	Stim Data Line 1	Bi-Directional	Digital
29	Ground		
30	Stim Data Line 2	Bi-Directional	Digital
31	Ground		
32	Stim Data Line 3	Bi-Directional	Digital
33	Ground		
34	Stim Data Line 4	Bi-Directional	Digital
35	Stim Channel 2 Power-Down	Input	Digital
36	Stim Data Line 5	Bi-Directional	Digital
37	Ground		
38	Stim Data Line 6	Bi-Directional	
39	Stim Reset	Input	Digital Active Low
40	Stim Data Line 7	Bi-Directional	Digital

JP2	**Stim Board**	**Header for Jumper**	
Pin #	**Signal Name**	**Type**	
1	Channel 3&4 Select	Input	Jumper Pin 2 to Here if this board is for Ch. 3&4 in a 4-Ch. Unit

2	Dual Port RAM Chip Enable	Input	Digital Active Low
3	Channel 1&2 Select	Input	Jumper Pin 2 to Here if this board is for Ch. 1&2 in ANY Unit

J1	**Stim Board**		
Pin #	**Signal Name**	**Type**	
1	Power Input	Input	8-18 VDC
2	Power Input	Input	8-18 VDC
3	Ground		
4	Ground		

J2	**Stim Board**		
Pin #	**Signal Name**	**Type**	
1	Hi-Volt Probe Output	Output	Stim Output, 0-500V Pulses
2	Hi-Volt Probe Pot Top	Output	Not Used
3	Hi-Volt Probe Pot Wiper	Input	Not Used
4	Ground		

J3	**Stim Board**		
Pin #	**Signal Name**	**Type**	
1	Channel 2 Output Low	Stim Output	0-100V Peak, Depends on waveform
2	No Connection		
3	Channel 2 Output Hi	Stim Output	0-100V Peak, Depends on waveform

J4	**Stim Board**		
Pin #	**Signal Name**	**Type**	
1	Channel 1 Output Low	Stim Output	0-100V Peak, Depends on waveform
2	No Connection		
3	Channel 1 Output Hi	Stim Output	0-100V Peak, Depends on waveform

J5	**Stim Board**	**(Not Used on Legend Series)**	

Pin #	Signal Name	Type	
1	Microcurrent Probe Output	Stim Output	-60 to 60V Peak or DC
2	Microcurrent Probe LED Anode	Not Used	
3	Microcurrent Probe Switch	Input	Digital
4	Microcurrent Probe Pot Top	Not Used	
5	Microcurrent Probe Pot Wiper	Not Used	
6	Ground		
7	No Connection		
8	Channel 1 Output Low	Not Used	

My Problem Is With . . .

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Find the topic that best describes your problem and turn to that section for troubleshooting help !

This troubleshooting guide will help you through a process of elimination. The key is to gather as many clues as possible. Observe the behavior of as many aspects of the unit's operation as possible. If there is no clear path or conclusion, use the information you have gathered as well as the theory of operation to guide you.

Intelect Legend Stim Error Messages Explained

Below is a list of the messages displayed on the LCD screen when an error is detected, as well as a brief explanation of the source of the message.

"Channels Needed for This Mode are Busy"

Either no channels are open to run a new signal, or the dedicated channel for HiVolt is already being used.

"Over Current Fault on Channels X-X"

Where X is a channel number. Indicates that a severe overcurrent was detected on the specified channel(s).

Intelect Legend US Error Messages Explained

Below is a list of the codes displayed on the LEDs when an error is detected.

HHH

The applicator has reached a temperature that is too high, and the US output has been stopped.

noHd

No ultrasound applicator detected.

E03

An attempt to set up an address on the onewire device failed.

E04

An attempt to read data from the ultrasound applicator failed.

E05

An attempt to program the ultrasound applicator failed. This only occurs during calibration.

E06

The ultrasound applicator memory is full. This only occurs during calibration.

E07

The memory device in the ultrasound applicator is not the proper type.

E08

The ultrasound applicator is uncalibrated.

Special Key Combinations

Intelect® Legend Stim

Here is a list of the key combinations available for adjusting LCD screen contrast and saving presets.

Adjust the Contrast UP

Channel 1 & Intensity Up

Adjust the Contrast DOWN

Channel 1 & Intensity Down

Save Current Output Settings

Pause & Enter

Intelect® Legend US

Here is the key combination for saving presets.

Save Current Settings

Intensity Up & Display (Watts / W/cm^2)

Problems Powering Up The Unit

If there is an indicator on the power supply, does it turn off when you turn the power switch on? (If there is no indicator use a voltmeter to monitor the power supply output.)

Yes - Try another power supply. If the results are the same, open the case of the unit and unplug the power connector to each board, one at a time, until the unit comes on properly. That will be the bad board.

No - Does it remain on?

Yes - Is there any indication that power is getting to the unit, such as the LCD or LEDs briefly flash or the beeper ticks?

Yes - Unplug everything but the power from the Control Board and see if it comes on. If not, then it is bad. If it did, the Stim board or US Generator Board is bad.

No - Check the fuse on the rear of the unit. Replace if blown.

No - Check the AC power source and the power cord. It could also be a bad power supply.

No Ultrasound Output

First, check that the duty cycle or intensity is not so low that you can't observe water movement on the applicator head. If there is some movement, but not as high as expected, use an ultrasound power meter to test the output. If it is low, then follow the Applicator Calibration Procedure in this manual.

If there is absolutely no output, try another applicator. Any Chattanooga Group applicator from an Intelect® Legend or CPS unit that has the same connector will work.

Did swapping the applicator fix the problem?

Yes - The applicator is bad.

No - The generator board is probably bad. Also check the connector and harness inside the unit.

If you do not have another applicator, you can check for output on the Ultrasound Generator Board using an oscilloscope. Refer to the Ultrasound Generator Board drawing and signal list in this manual. If there is output at the board connector, the applicator is bad.

No Stim Output

Does the display change when a treatment is selected?

No - The Stim Board is probably bad. Also check the connector and harness inside the unit.

Yes - First be sure the leads and electrodes are good. If possible test the output with a resistor.

Next be sure the output type is available at the channel you are monitoring. For example, HiVolt is only available from channel 2. See the manual.

Also check the output harnesses and connectors or monitor the output at the connector on the Stim Board.

If these checks do not reveal the source of the problem and there is no output in one or more treatment modes, the Stim Board is faulty.

Applicator Detection and Data Reading Problems

To help diagnose these problems, keep in mind how the unit operates. The unit determines whether an applicator is connected based on the voltage from the thermistor in the applicator. If the applicator is unplugged, the voltage rises to 5V from its normal 2-3V. This is sensed and the unit will then try to get the memory device in the applicator to acknowledge a reset signal. If this fails, the message "noHd" is displayed. On the other hand, if the voltage drops low, it is interpreted as the head overheating and "HHH" is displayed. This is also what would happen if the applicator was shorted.

The voltage can be monitored WHILE THE ULTRASOUND GENERATOR IS NOT RUNNING by measuring the voltage on the output pin of the connector on the Ultrasound Generator Board. Refer to the board drawings and signal lists.

The calibration data is read both at start-up and when US is selected. Errors E03, E04, E07 and E08 are due to problems in the communications at these times. This can be caused by either the Applicator or the Ultrasound Generator Board. The easiest way to determine which is bad is by trying another Applicator. The unit will continue to give error messages if the Ultrasound Generator Board is defective. If this is not possible, monitoring the output line while the unit is trying to read the calibration data can help determine which component is bad. Under normal conditions, a fast pulse train is seen as the data is passed from the Applicator to the Generator Board with an amplitude of 5V. If the amplitude is 12V, the Ultrasound Generator Board is faulty. If the pulse train is not observed, unplug the applicator and try pressing the Frequency button while monitoring the output. If a single 5V pulse is observed, the Applicator is bad. If no activity is seen then the Ultrasound Generator Board is bad.

During calibration of the Applicator, an error message E06 means that there is no more room in the memory device to store the calibration data. The Applicator will have to be replaced. An E05 message could be due to either the Applicator or the Ultrasound Generator Board. Use the information in the previous paragraph to diagnose which it is.

Applicator Overheating

This is not normally due to any malfunction of the unit, but rather is related to the coupling of the head to the patient. If good coupling (contact) to the skin is not maintained during treatment the head can heat up. If the head gets too hot, the unit will pause the treatment and display "HHH" in the display. The only part that would be bad under these circumstances would be the Applicator.

For problems related to the Head Warming feature, refer to that section.

Head Warming Problems

Usually an explanation of exactly how this feature works will help you determine if the problem is due to the Applicator or the Ultrasound Generator Board.

When Head Warming is selected, the ultrasound output is turned on at half the maximum output for the head size, and the frequency is set to 3 MHz. The head temperature is monitored and when it reaches a temperature slightly above skin temperature the output is reduced to a level of about 10% of maximum to maintain the temperature. If the temperature rises above the skin temperature while at the 10% level, the output is turned off until the temperature falls back down. On the other hand, if the temperature rises to the maximum head temperature, the unit will display "HHH" and the output will be turned off to protect the crystal in the Applicator. Bear these facts in mind: at any time Head Warming is on the output can be off, at 10% or 50% of maximum and the unit is functioning normally. Reaching "HHH" occasionally would not be abnormal but could indicate that the Applicator is extremely inefficient. Recalibration (see the Applicator Calibration Procedure) or replacement would be required to correct this.

If the head never warms up, check for output at 3 MHz by selecting 3.3MHz, Continuous and pressing Start. Is there output at 3 MHz?

Yes - Something is malfunctioning on the Ultrasound Generator Board.

No - Remember that Head Warming uses the 3 MHz output. The Applicator may need to be recalibrated for 3 MHz operation (see the Applicator Calibration Procedure) or be replaced.

Display Related Problems

Stim unit LCD

Is the LCD screen completely black?

Yes - Adjust the contrast. Is the problem corrected?

No - The LCD screen should be replaced.

No - Is the LCD screen garbled ? (lines, odd text, etc.)

Yes - Is the problem consistent? (If there is a line across the screen, is it always in the same place?)

Yes - The problem is most likely the LCD display.

No - The problem is usually the Control Board.

No - Is the LCD screen completely blank?

Yes - Are there other signs that the unit is functioning such as the fan runs when a treatment is selected and the intensity increased? If not, check the items in the Power-On section. Otherwise, try adjusting the contrast. If that doesn't correct the problem, it could be in either the LCD or the Control Board. Check the signals on JP4 (refer to the signal list) to help determine which it might be.

No - See the section titled "My Problem Isn't Described Here" for some additional troubleshooting tips. Your problem will be either a defective Control Board or LCD screen, or possibly the connection between them.

Ultrasound unit LEDs

Are any LEDs working?

Yes - The Control Board is faulty.

No - Are there other signs that the unit is functioning such as the fan runs when Start is pressed and the intensity increased? If not, check the items in the Power-On section. If those checks reveal that there is power to the Control Board, then it is faulty.

Settings Return to Defaults After Adjustments

This is usually caused by a faulty Membrane Switch. If a switch sticks, the function it performs can cause changes in the parameters selected and other odd behavior.

Occasionally this can be due to a defective Control Board as well.

My Problem Isn't Described Here !

While we have tried to make this manual as complete as possible and include as much troubleshooting help as we can, there will still be some problems which haven't been foreseen or are so rare as to not be included.

Some tips:

•Always begin by reading the Theory of Operation and review the Signal Lists. By understanding what the unit is supposed to be doing and how the circuit boards communicate, you can usually probe some of the signals and/or swap some boards and determine the source of the problem.

•Observe the unit's operation and find as many details of the problem as possible, such as the mode it occurs in, settings, etc.

•Is the problem repeatable or intermittent?

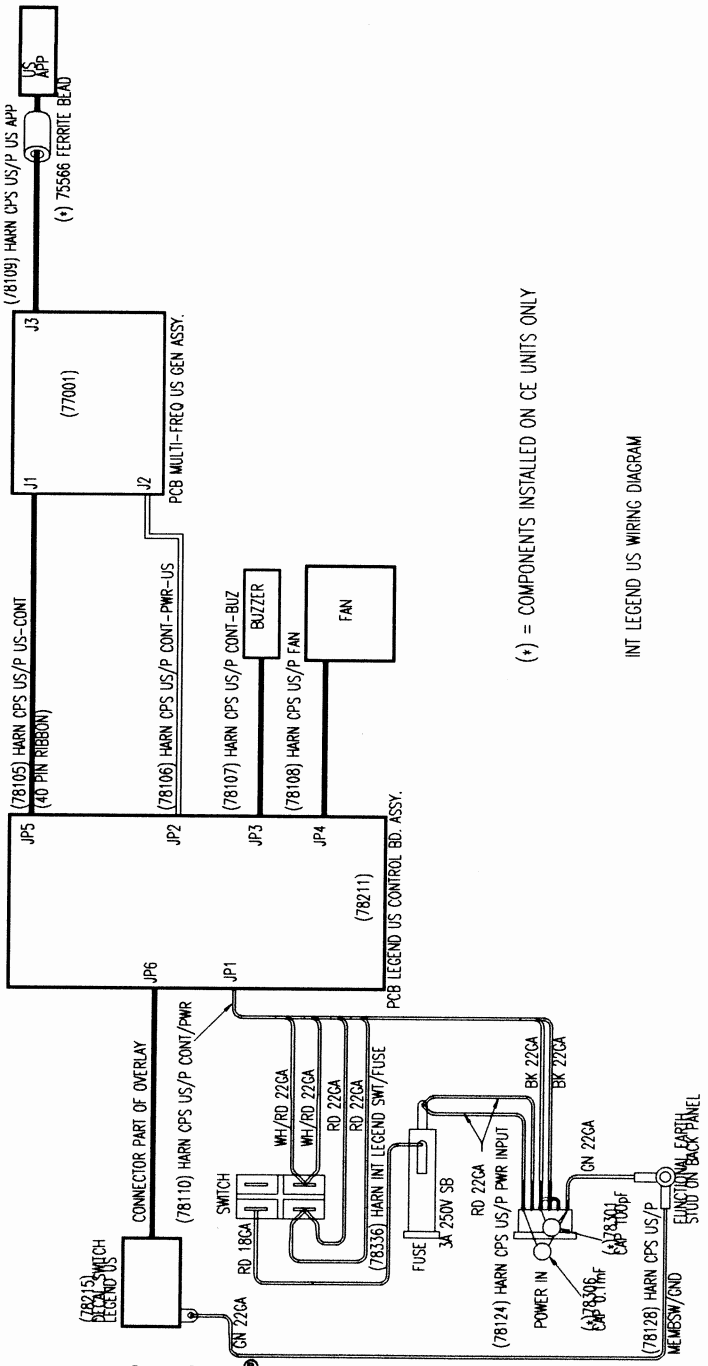
•Consider parts that may wear as more likely to fail.

•Examine the circuit boards carefully for signs of failed components such as oily residue underneath an electrolytic capacitor, charred or broken components.

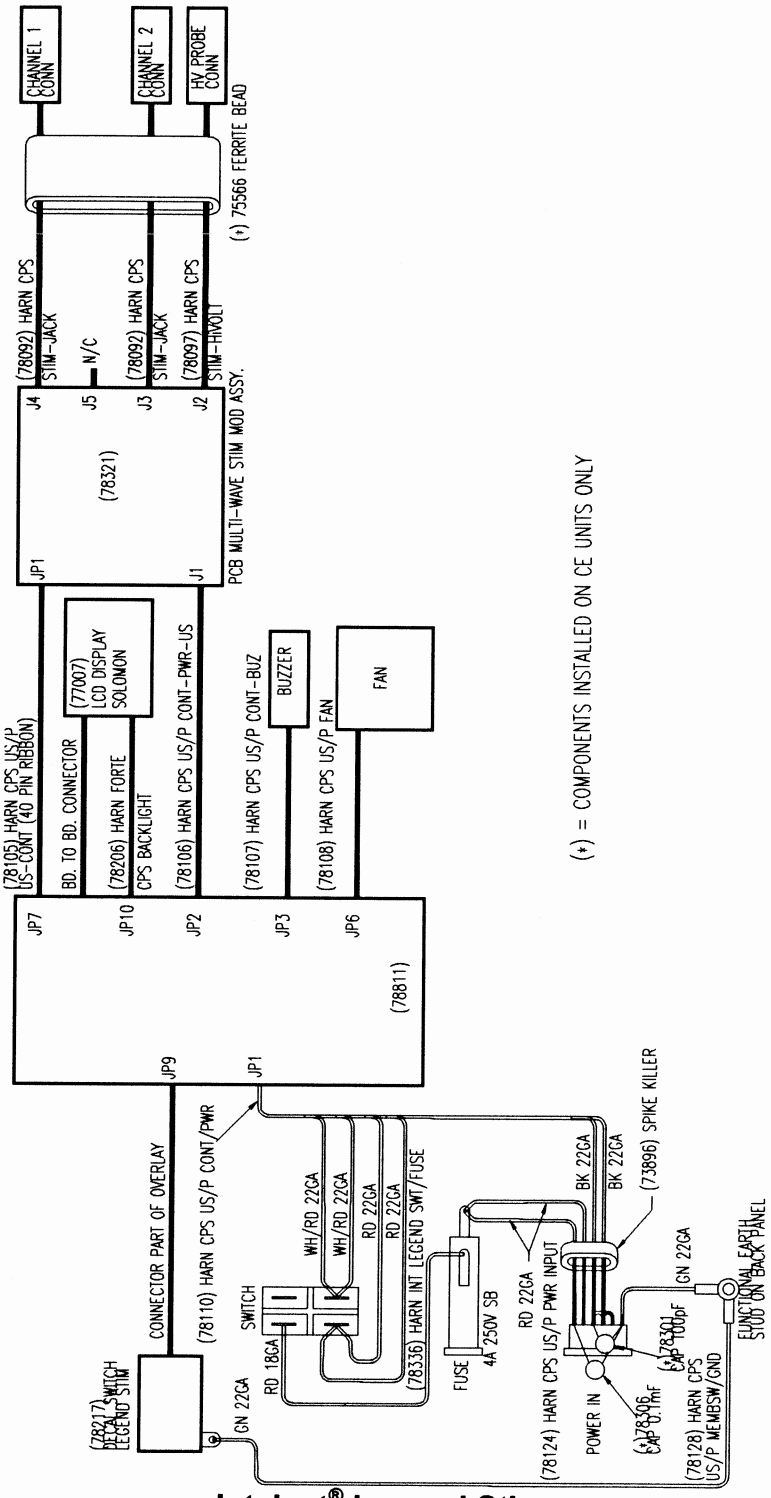
•Replace the complete circuit board, do not attempt to repair it.

Wiring Diagrams

These pages have the wiring diagrams for the Intelect® Legend Ultrasound and Intelect® Legend Stim units. Refer to them for connection information and part numbers.



Intelect® Legend Ultrasound



Intelect® Legend Stim

Calibration Procedures

These calibration procedures apply to calibration of the Intelect® Legend Ultrasound and Intelect® Legend Stim units. Following it is a calibration procedure for the ultrasound applicators.

Intelect® Legend Stim Calibration Procedure

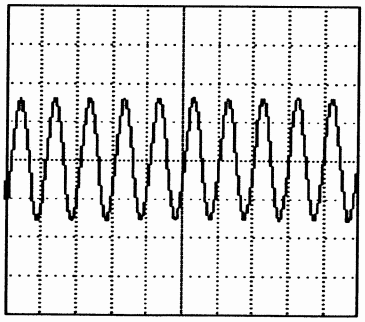
Equipment Required:
Oscilloscope
Scope Probe (X10)
(2) 510-ohm Loads

A. Unit Startup and Fan Testing

1. Plug the 510-ohm loads into the output jacks. With the unit properly plugged into its power supply, turn the unit on. The unit should beep once, time and output screen should display and the fan should be blowing inward. Check for excessive fan noise.

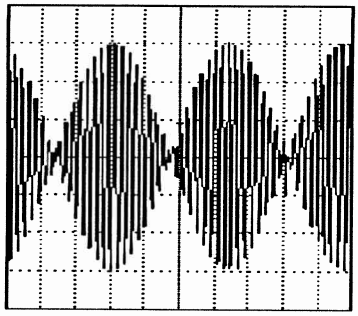
B. Stimulator Test

1. **IFC**: Connect scope probe across load on Channel 1. Press IFC and heading of menu should display: Ch1-2: IFC. Press Up Intensity arrow to increase Output to 50ma and press Start. Screen should change to opening display listing: Channel 1 IFC at top and timer display in large letters counting down from 15:00 and Output at 50ma. Below the output is: Ch2 IFC. Verify waveform is similar to that shown below with oscilloscope. Move the oscilloscope probe to the Channel 2 load and verify that the waveform is similar to that shown below using the oscilloscope. Press Pause and observe the output. Main display will show a P beside the output and output will drop to 0.0ma . Press Pause to restart and Stop to reset.



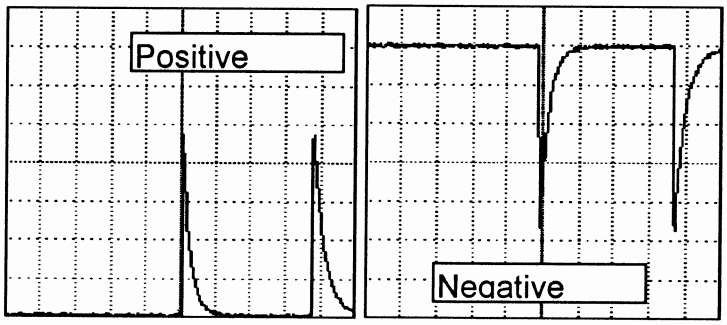
IFC waveform; 'scope set to 20V/div & .2mSec/div

2. **Premod**: With the oscilloscope probe on channel 2, press Channel 2 button. Press Premod and observe: Channel 2 Premod. Adjust output with Intensity arrow to 50ma and press Start. Main screen should display Channel 2 Premod with timer counting down from 15:00 and 50ma as output with Ch1 - Avail below. Verify waveform is similar to that below using the oscilloscope. Press Stop to reset.



Premod Waveform; 'scope set to 10V/div, 1mSec/div

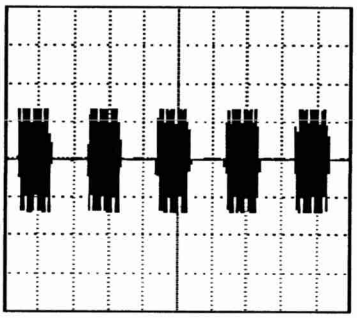
3. **HiVolt**: Press HiVolt and Main Menu should display at top: Ch2: High Volt. Time should be set to 20:00 and Int should now read 0v. Press Enter to select Probe. Output must display 0v. Press Enter again to select Pads. Increase Output with the Intensity up button to 500. Press Start and verify that the output waveform is similar to that shown below. Press Enter and use Main Menu down button to move to Polarity. Toggle polarity from positive to negative and observe that the waveform changes as shown below. Press Stop upon successful completion.



Hi-Volt Waveforms; 'scope set to 50V/div, 20uSec/div

4. **Russian**: Press Channel 1 button. Press Russian & observe: Channel 1 Russian . At Mode, press Enter and select CoContract and press Enter again. Main Menu heading must say: Ch1-2: Russian. Move down to Cycle Time with the arrow keys and press Enter. Select Continuous and press Enter again. Increase Intensity with the arrow key to maximum 100ma and press Start. Verify on Main screen that both Channels reach 100 by pressing the Channel 1 and 2 button. Verify that the output

waveform on both channels is similar to that shown below using the oscilloscope.



Russian Waveform; 'scope set to 50V/div, 5mSec/div

Press pause to pause the operation and then press the Up and Down Time buttons to confirm that the time changes. Set the treatment time to 1 minute and push Start. Upon completion, you should hear 2 beeps, a pause, and then 2 more beeps to indicate end of treatment. The output must be at zero at this time.

C. Screen Intensity Adjustment

1. Hold Channel 1 and Intensity up or down button to adjust the screen for proper display.

   Remove power; Test is complete!

Intelect® Legend US
Calibration Procedure

Note: All caps indicate a front panel button.

1. Plug the applicator and appropriate power supply into the unit. Plug the power supply into an appropriate outlet and turn the unit on. It should beep and the LEDs should illuminate, then fill with default time, duty cycle, and frequency.
2. Unplug the applicator. The message 'noHd' should appear in the treatment time display. Plug the applicator back in, press a key and observe that the message disappears.
3. Press HEAD WARM. The fan should start and output will be displayed on the LEDs. Pressing it a second time will stop the fan and the output will return to 0.0.

4. Press the FREQUENCY button and verify that 1 MHz and 3 MHz LEDs are illuminated. Leave 1 MHz selected.
5. Press DUTY CYCLE until Continuous is illuminated, noting that each LED is functioning. Use the INTENSITY up button to set the output to 2.0W/cm^2. The fan should begin running. Press START. By applying a small amount of water to the transducer, verify that there is ultrasound output.
6. Observe that the treatment time counts down on the LEDs. Press PAUSE. The output should stop, the fan should stop and the treatment timer should stop counting down. Press START and the output should resume. Press STOP and verify that the output stops, the treatment timer is reset back to the default, the output display is reset back to 0.0 and the fan stops.
7. Use the TIME up button to verify that the treatment time will not go above 15 minutes. Use the DOWN button to set the time back to 1 minute. Select 10% Duty Cycle using the DUTY CYCLE button, increase the intensity to maximum and press START. While the unit is running, press the DISPLAY button and verify that the displayed power changes from 2.0 W/cm^2 to 10.0 Watts (assuming a 5cm applicator is attached). Allow the unit to run until treatment time runs out. Two beeps should be heard followed by another two beeps and then the display will clear back to the default.
8. Testing complete.

Intelect® Legend Applicator Calibration Procedure

1. Put unit into calibration mode. Turn the unit ON while holding down the Intensity UP button. It is not necessary to hold the button down after the initial beep sound.

2. The Min/Sec display should read CAL0 indicating that the machine is in calibration mode and at the first calibration step.

3. Place the applicator into the Ultrasound power meter.

4. Select the calibration frequency using the FREQUENCY button (1MHz or 3MHz).

5. Set the Head Size using the DUTY CYCLE button.
   10% = 1cm applicator
   20% = 2cm applicator
   50% = 5cm applicator
   Continuous = 10cm applicator

6. Once Applicator size and Frequency are chosen, push the START button. This will begin the scan and calibration. The zero in CAL0 will flash while the scan is in progress. Do not disturb the machine while it is scanning.

7. When the scan is complete the display will change to CAL1.

8. Re-zero the Ultrasound power meter.

9. Using the Intensity UP button, increase the output until the power meter reads 4 (four) watts.

10. Push the START button. The unit will hold the settings in memory. The display will change to CAL2.

11. If you are satisfied with the calibration, push START.

12. The unit will beep to indicate that the new calibration values have been stored in the applicator.

13. The display will change to CAL0 and is now ready for the next calibration.

14. After both frequencies have been calibrated and before removing the applicator head from the power meter, check the accuracy of the power calibration. Cycle the power to the unit off and then back on. Select continuous duty cycle and increase the output to the settings listed. Verify that the power indicated on the UPM-DT-10 power meter is within the indicated range. Check power at both 1 MHz and 3.3 Mhz.

Head size	Power level	Output range
2 cm^2	2 watts	1.72-2.28
	4 watts	3.44-4.56
5 cm^2	5 watts	4.3-5.7
	10 watts	8.6-11.4
10 cm^2	5 watts	4.3-5.7
	10 watts	8.6-11.4
	15 watts	12.9-17.1
	20 watts	17.2-22.8

15. Calibration complete. If you are not satisfied with the calibration and wish to start over, turn the machine OFF and begin at step one listed above.

Technical Specifications

Listed here are the specifications for the Intelect® Legend Ultrasound.

Dimensions: 8.25" x 11" x 2.5"
Weight: 2 lb.
Applicators: 2, 5, & 10 cm²
Power: 90V-264V, 47-63Hz

2 cm² Applicator

Frequency (Mhz):	1.0 MHz, 3.3 MHz (all +/- 5%)
Power (watts):	0.2 watt to 4 watts
ERA (cm²):	1.8 cm²
Effective Radiating Area:	1.8 cm² +/-0.4 cm²
Maximum beam non-uniformity ratio:	6.0:1
Beam type:	Collimating

5 cm² Applicator

Frequency (Mhz):	1.0 MHz, 3.3 MHz (all +/- 5%)
Power (watts):	0.4 watt to 10 watts
ERA (cm²):	4.0 cm²
Effective Radiating Area:	4.0 cm² +/-1.0 cm²
Maximum beam non-uniformity ratio:	6.0:1
Beam type:	Collimating

10 cm² Applicator

Frequency (Mhz):	1.0 MHz, 3.3 MHz (all +/- 5%)
Power (watts):	1 MHz: .1 watt to 20 watts, 3.3 MHz: 1-10 watts
ERA (cm²):	8.5 cm²
Effective Radiating Area:	8.5 cm² +/-1.5 cm²
Maximum beam non-uniformity ratio:	6.0:1
Beam type:	Collimating

Duty Cycle

Pulsed: 10%, 20%, 50%
Continuous: 100%

Pulse Duration:

5 msec +20% (50% duty cycle, pulsed mode)
2 msec +20% (20% duty cycle, pulsed mode)

Ultrasonic Power:

10 cm^2 crystal at 1.0 MHz:	Variable from 1 watt to 20 watts
10 cm^2 crystal at 3.3 MHz:	Variable from 1 watt to 10 watts
5 cm^2 crystal:	Variable from 0.4 watt to 10 watts
2 cm^2 crystal:	Variable from 0.2 watt to 4 watts

Listed here are the specifications for the Intelect® Legend Stim.

Interferential

Output Channels:	1 & 2
Amplitude:	0-50 mA RMS into a 500 ohm load
Current Limit:	50 mA RMS
Voltage (max.):	200 Volts Peak to Peak
Carrier Frequency:	5000 Hz
Beat Frequencies:	0-200 Hz

Premod

Channels:	1 & 2
Amplitude:	0-50 mA RMS into a 500 ohm load
Current Limit:	50 mA RMS
Voltage (max.):	200 Volts Peak to Peak
Carrier Frequency:	2000-5000 Hz
Beat Frequency:	0-200 Hz

Russian

Channels:	1 & 2
Amplitude:	0 to 100 mA RMS into a 500 ohm Load (During On-Time of Burst)
Current Limit:	50 mA Average
Voltage (max.):	200 Volts Peak to Peak
Carrier Frequency:	2500 Hz
Burst Frequency:	20-100 Hz
Duty Cycle:	10% to 50%

HiVolt

Description: The output is a fast-rising dual pulse with approximately 75 microseconds spacing between pulses.

Pulse duration: First peak is 5 microseconds at one-half pulse height and second peak is 8 microseconds at one-half pulse height. These measurements are with a load impedance of 1,000 ohms. Pulse duration varies according to body impedance (load resistance).

Channel:	2 Only
Voltage Current:	0-500 Volts
Output Current:	0-2500 milliamps peak
Frequency:	1-120 pulses per second

Parts List

The following is a list of replaceable parts for the Intelect® Legend Ultrasound and Intelect® Legend Stim units with their Chattanooga Group part numbers.

78211	Intelect Ultrasound Control Board Assembly
78811	Intelect Stim Control Board Assembly
77001	Ultrasound Generator Board Assembly
78321	Stim Generator Board Assembly
78234	2cm Applicator Assembly
78233	5cm Applicator Assembly
78232	10cm Applicator Assembly
78105	40 Conductor Cable Assembly, Control Bd to US Generator Bd
71741	3- Ampere Slo-Blo Fuse
72315	4- Ampere Slo-Blo Fuse
77007	LCD Screen
78108	Fan for CPS Ultrasound or Stim
78215	Intelect Ultrasound Membrane Switch
78217	Intelect Stim Membrane Switch
78121	120VAC Power Cord
78082	Intelect Ultrasound or Stim Power Supply
78113	UL-544 Power Supply
78107	Buzzer for Intelect Stim or Ultrasound
78023	Power Switch
78109	Ultrasound Output Harness
78092	Stim Output Harness
78097	Stim HiVolt Output Harness